SECTION 22 0548

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

****

LANL MASTER SPECIFICATION

When editing to suit project, author shall add job-specific requirements and delete only those portions that in no way apply to the activity (e.g., a component that does not apply). To seek a variance from applicable requirements, contact the ESM Mechanical POC.

When assembling a specification package, include applicable specifications from all Divisions, especially Division 1, General Requirements.

Delete information within “stars” during editing.

Specification developed for ML-3 / ML-4 projects. For ML-1 / ML-2, additional requirements and QA reviews are required.

This specification addresses seismic protection requirements for Performance Category (PC) 1 and PC-2 mechanical components. Refer to ESM Chapter 5 – *Structural* for seismic protection design requirements that are required for PC-1 and PC-2 components. Also refer to ESM Chpt 5 – Structural for additional seismic protection design requirements that will be required for PC-3 and PC-4 components.

Use this specification in conjunction with Section 13 4800 Sound, Vibration, and Seismic Control.

****

PART 1 GENERAL

1.1 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Refer to Section 01 4219, Reference Standards, for date of publication to follow:

1. AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

2. ASCE 7 Minimum Design Loads for Buildings and Other Structures.

3. INTERNATIONAL CODE COUNCIL

4. International Building Code (IBC)

1.2 SECTION INCLUDES

A. Provide hangers, supports, anchors, concrete bases, sleeves, inserts, seals, and other positive fastenings for mechanical components such that in-service loads and seismic forces are safely transferred to the structure and relative seismic displacements of supporting structures are adequately accommodated.

1.3 ITEMS NOT COVERED BY THIS SECTION

A. Fire Protection Systems

1. Seismic protection of piping for fire protection systems shall be installed as specified in Sections 21 1313 Wet-Pipe Sprinkler Systems, 21 1316, Dry-Pipe Sprinkler Systems, 21 1319 Pre-Action Sprinkler Systems, 21 1326 Deluge Fire Suppression Sprinklers, 21 1339 Foam-Water Systems and 21 2200 Clean Agent Fire-Extinguishing Systems.

1.4 SEISMIC PROTECTION

****

NOTE: The requirements for seismic protection measures described in this section apply to all mechanical components except for the following:

- Mechanical components where the Component Importance Factor, I_p, = 1.0, and flexible connections between the components and associated conduits are provided, and the components are mounted at 4 ft or less above the floor, and the components weigh 400 lb or less
- Mechanical components weighing 20 lb or less where I_p = 1.0 and flexible connections between the components and associated conduits are provided
- Mechanical distribution systems weighing 5 lb/ft or less where I_p = 1.0

Seismic restraints are not required for HVAC ducts with I_p = 1.0 if either of the following conditions are met:

- HVAC ducts are suspended from hangars 12 inches or less in length from the top of the duct to the supporting structure. The hangars shall be detailed to avoid significant bending of the hangars and their attachments. If the 12-inch length requirement is exceeded by any one hangar in a run then the entire run shall be seismically restrained.
- HVAC ducts have a cross-sectional area of less than 6 square feet.

Seismic supports are not required for ductile piping with I_p = 1.5 and a nominal pipe size of 1 inch or less when provisions are made to protect the piping from impact or to avoid the impact of larger piping or other mechanical equipment

Seismic supports are not required for ductile piping with I_p = 1.0 and a nominal pipe size of 3 inches or less.

Accomplish resistance to lateral forces induced by earthquakes without consideration of friction resulting from gravity loads.

Design the functional and physical interrelationship of components and their effect on each other so that the failure of a mechanical component shall not cause the failure of a nearby life-safety, safety-significant, or safety class mechanical or electrical component.

Seismic Criteria: Use the following criteria to calculate seismic design forces and relative seismic relative displacements in accordance with the IBC and ASCE 7:

- Seismic Design Category = D
- SDS = design spectral response acceleration at short periods
- SDS = 0.54g
- Amplification, Response Modification and Importance factors (i.e., ap, Rp, Ip) listed in ASCE 7.

****

A. Provide seismic protection in accordance with the IBC, ASCE 7, and additional data furnished in this Section and Section 13 4800 Sound, Vibration and Seismic Control.

****

Edit B to match project conditions; add items to list as required; delete items not included in the Project. It may be necessary to note the equipment IDs for the particular items of equipment (e.g. BHW-1, CWR-B, etc.) that must meet the requirements of this article. Delete the article if there is no equipment with I_p greater than 1.0.

NOTE: Seismic protection does not guarantee that the equipment itself is rugged enough to survive earthquake shaking. When a piece of equipment is required to remain operational after an earthquake, consult the manufacturer regarding the capabilities of the equipment to withstand seismic loading.

****

B. Equipment Qualification: The following equipment designated with I_p greater than 1.0 and furnished under this contract shall be certified by the manufacturer to withstand the total lateral seismic force and seismic relative displacements specified in the IBC or ASCE 7. Component manufacturer's certification shall be based on shake table testing or experience data (ie., historical data demonstrating acceptable seismic performance), or by more rigorous analysis providing for equivalent safety. Required response spectra shall exceed 1.1 times the in-structure spectra determined in accordance with IBC AC156 *Acceptance Criteria for Seismic Qualification by Shake-Table Testing of Nonstructural Components and Systems*.

1. Boiler[s] [BHW-1]
2. Chiller[s] [CWR-B]
3. Air-Conditioner, Refrigerant[s] [ACR-3]
4. Expansion Tanks[s] [TX-E]
5. [_____]

****

NOTE: Edit 1.5 to match project requirements.

****

1.5 QUALITY ASSURANCE

A. Provide hangers, supports, and seismic protection that conforms to the requirements of the following codes and standards:

1. IBC
2. ASCE 7
3. [_____]

****
NOTE: Edit 1.6 to match project requirements.
****

1.6 SUBMITTALS

A. Submit the following in accordance with the provisions of Section 01 3300 Submittal Procedures.

B. Catalog Data: Submit catalog data for each type of product specified. Include information substantiating equivalent corrosion resistance to zinc coated steel of alternative treatment, finish, or inherent material characteristic.

C. Material List: Submit hanger and support schedule showing manufacturer's figure number, size, spacing, features, and application for each required type of hanger, support, sleeve, seal, and fastener to be used.

****
Edit D to match project conditions; add items to list as required; delete items not included in the Project.
****

D. Shop Drawings: Submit shop drawings showing details of fabricated hangers, supports, and seismic protection of all mechanical equipment and components such as the ones listed below. Provide detail drawings along with catalog cuts, templates, and erection and installation details, as appropriate, for the components listed below. Submittals shall be complete in detail; shall indicate thickness, type, grade, class of metal, and dimensions; and shall show construction details, reinforcement, anchorage, and installation with relation to the building construction.

1. Boilers and furnaces
2. Storage Tanks (Fuel, Oil, Water, etc.) inside of, or on top of, buildings
3. Water Heaters
4. Expansion Air Separator Tanks
5. Valves and Fittings for Piping
6. Heat Exchangers
7. Steam-fed Kitchen Appliances
8. Water Chiller Units
9. Thermal Storage Units
10. Cooling Towers inside of, or on top of, buildings
11. Air and Refrigerant Compressors
12. Refrigerant Piping
13. Air Handling Units
14. Pumps with Motors
15. Lab Scrubbers
16. Large Commercial Dryers
17. Pollution Control Equipment
18. Gas Dryers

19. Ducts

20. Flash Tanks

21. Unit Heaters

22. Accumulator Tank

23. Exhaust and Return Fans

24. Solar Heating Units

25. Fuel Piping Outside of Buildings

26. All Water Supply Systems

27. Storm and Sanitary Sewer Systems

28. All Process Piping

29. Pneumatic Tube Distribution System

30. Cold Storage Refrigeration Systems

31. Condenser Water Piping Outside the Building

32. Chilled Water Distribution Systems Outside of Buildings

33. Heat Distribution Systems (Supply, Return, and Condensate Return) Outside of Buildings

34. All Piping Inside the Building Except as Specifically Stated Above Under "Items Not Covered By This Section"

35. [_____]

****

Edit E to match project conditions; delete if not required by Project.

****

E. Certifications: Submit manufacturer's certification of compliance indicating compliance with Clause 9.6.3.6 of ASCE 7 for mechanical components with I_p greater than 1.0. Submit shake-table test results or experience data with certifications.

PART 2 PRODUCTS

****

NOTE: In corrosive environments, appropriate materials for structural supports must be used. Dissimilar metals must be isolated.

If deemed necessary, author should include reference to other specification sections containing provisions for pipe pressure and temperature ratings.

****

2.1 GENERAL

A. Refer to Section12 4800, Sound, Vibration and Seismic Control for general seismic protection products.

2.2 SUBSTITUTIONS

A. Alternate products may be accepted; follow Section 01 2500, Substitution Procedures.

B. As is the case with all LANL projects, substitutions are permitted unless noted otherwise; however, “approved equal” non-building structures and seismically protected non-structural components must be reviewed and approved by the design structural engineer.

2.3 FLEXIBLE COUPLINGS

A. Flexible couplings shall have 1-1/2 times the pressure and temperature ratings as adjoining pipe.

2.4 FLEXIBLE BALL JOINTS

A. Flexible ball joints shall have cast or wrought steel casing and ball parts capable of 360-degree rotation with not less than 15-degree angular movement.

2.5 FLEXIBLE MECHANICAL JOINTS

A. Mechanical couplings for steel or cast iron pipe shall have 1-1/2 times the pressure and temperature ratings as adjoining pipe, be of the sleeve type and shall provide a tight flexible joint under all reasonable conditions, such as pipe movement caused by expansion, contraction, slight settling or shifting of the ground, minor variations in trench gradients, and traffic vibrations. Where permitted in other sections of these specifications, joints utilizing split-half couplings with grooved or shouldered pipe ends may be used.

B. Sleeve-type couplings shall be used for joining plain-end pipe sections. The coupling shall consist of one steel middle ring, two steel followers, two gaskets, and necessary steel bolts and nuts to compress the gaskets.

2.6 MANUFACTURED BALL JOINTS

A. Manufactured ball joints shall be as recommended by the manufacturer for the intended use, and shall be approved by LANL before installation.

2.7 SWAY BRACING MATERIALS

A. Sway bracing materials (e.g. rods, plates, rope, angles, etc.) shall be as specified in Section 13 4800, Sound, Vibration and Seismic Control.

2.8 AUTOMATICALLY ACTUATED NATURAL GAS SHUT-OFF VALVES

A. Use of automatically actuated gas shut off-valves is not permitted

2.9 CONCRETE FORMWORK

****
Edit A to match specification sections used in Division 3.
****

A. Refer to Section 03 3001, Reinforced Concrete.

2.10 CONCRETE REINFORCEMENT

****
Edit A to match specification sections used in Division 3.
****

A. Refer to Section 03 3001, Reinforced Concrete.

2.11 CAST-IN-PLACE CONCRETE

****
Edit A to match specification sections used in Division 3.
****

A. Refer to Section 03 3001, Reinforced Concrete.

PART 3 EXECUTION

3.1 GENERAL

****
NOTE: Locate each item of rigid mechanical equipment entirely on one side only of a building expansion joint.

Piping, ducts, etc., which cross an expansion joint to rigid mechanical equipment, shall have flexible joints that are capable of accommodating calculated thermal and seismic displacements.
****

A. Refer to Section 13 4800, Sounds, Vibration and Seismic Control for general seismic protection installation requirements.

B. Install hangers, supports, and seismic protection according to ASCE 7, and requirements in this Section.

C. Conform to manufacturer's instructions and recommendations for installation of hangers, supports, and seismic protection.

D. Do not use wire or perforated strap for permanent mechanical supports.

E. Attach each item of rigid mechanical equipment as shown.

F. Provide piping, ducts, etc., which cross an expansion joint to rigid mechanical equipment, with flexible joints as shown.

3.2 EXAMINATION

A. Examine surfaces to receive hangers, supports, and seismic protection for compliance with installation tolerances and other conditions affecting performance of the system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.3 COUPLING AND BRACING.

****

NOTE: Unless otherwise determined by LANL, designs must include complete seismic details showing coupling requirements.

The design is for the supports of the component/system, not the component/system itself. Bracing does not guarantee that the component/system is rugged enough to survive earthquake shaking. When a component/system is required to remain operational after an earthquake, the manufacturer should be consulted regarding its capabilities to withstand seismic loading in accordance with ASCE 7.

The following provisions apply to all piping within a 5 foot line around outside of building unless piping is buried in the ground:

- Piping grouped for support on trapeze-type hangers shall be braced at the most frequent interval as determined by applying the requirements ASCE 7 and this Section to each piping run on the common support.
- Bracing components shall be sized as required for the total load carried by the common supports.
- Where rigid attachment would interfere with thermal expansion of piping, design of bracing shall not result in such attachment to pipe flanges, or similar.

****

A. Provide bracing and coupling as shown and as specified below.

3.4 SEISMIC RELATIVE DISPLACEMENTS

****

NOTE: Using the procedures in ASCE 7, the author will determine the expected seismic relative displacements and drift ratios.

Joints for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators must be capable of accommodating the required relative displacements.

Horizontal piping across expansion joints must be capable of accommodating the resultant of the drifts of each building unit in each orthogonal direction.

Piping with manufactured ball joints must be capable of accommodating the seismic drift (i.e., deflection per unit of height above the base where the seismic separation occurs).

Insert the required flexibility (e.g., inches of relative displacement, etc.) in the blank space.

****

A. Joints capable of accommodating [____] shall be provided and installed for vertical piping between floors of the building, where pipes pass through a building seismic or expansion joint, or where rigidly supported pipes connect to equipment with vibration isolators.

B. Piping capable of accommodating [____] shall be provided and installed for horizontal runs across expansion joints.

C. For threaded piping, swing joints made of the same piping material shall be provided and installed.

D. Piping capable of accommodating [____] shall be provided and installed for piping with manufactured ball joints; this value shall be used in place of the expansion given in the manufacturer's selection table.

3.5 FLEXIBLE COUPLINGS OR JOINTS

A. Building Piping

****

NOTE: Flexible couplings or joints in building piping are required at bottom of all pipe risers as required to accommodate force and displacement provisions of ASCE 7.

Flexible couplings or joints shall be braced laterally without interfering with the action of the flexible coupling or joint.

Cast iron waste and vent piping need only comply with these provisions when caulked joints are used.

Flexible bell and spigot pipe joints using rubber gaskets may be used at each branch adjacent to tees and elbows for underground waste piping inside of building to satisfy these requirements
****

1. Provide flexible couplings/joints in building piping as shown.

2. [Provide flexible bell and spigot pipe joints using rubber gaskets at each branch adjacent to tees and elbows for underground waste piping inside of building.]

B. Underground Piping

****

NOTE: The author will coordinate the requirements for seismic isolation of piping with the structural and civil design drawings to locate flexible connections as required.

The amount of annular space will depend on the stiffness of the foundation assembly and of the surrounding soil, and the distance between the foundation wall and the point outside the building where the pipe is considered to be restrained. The author will determine the pipe length necessary to provide fixity. As an approximation, a value of 3 inches would be necessary for a pipe penetration in a one-story basement in soft soil.

Underground piping requires flexible couplings where the piping enters the building as required to meet the IBC seismic design requirements. Additional flexible couplings shall be designed as necessary. For heat distribution systems, the “flexible coupling” used shall not undergo heat-related degradation over time.

Insert the required flexibility (e.g., inches of relative displacement, etc.) in the blank space.
****

1. Couplings capable of accommodating [_____] shall be provided and installed where shown.

3.6 PIPE SLEEVES AND SEALS

****
NOTE: The author will determine the amount of differential movement of piping at pipe sleeves passing through non-fire-rated walls and partitions and will indicate on the drawings the amount of clearance required between the pipe and the sleeve based on deflection of the pipe between sway braces on either side of the wall.

The author should avoid pipe penetrations through fire-rated assemblies.

Edit A to match Project requirements.
****

A. Provide pipe sleeves in concrete slabs and walls and all other fire-rated floors and walls for piping installations.

B. Sleeves through fire-rated wall or floor construction shall conform to the requirements in Section 07 8400, Firestopping. Follow manufacturer's instructions to restore original fire rating of wall or slab

C. Pipe sleeves in interior non-fire-rated walls shall be sized as indicated on the drawings to provide clearances that will permit differential movement of piping without the piping striking the pipe sleeve.

****
Edit D to match Project requirements.
****

D. Provide seals for pipe penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

E. Request inspection of firestop installations by LANL both before and after installation of firestop materials.

3.7 SPREADERS

****
NOTE: Spreaders are required between adjacent piping runs to prevent contact during seismic activity whenever the force and displacement provisions of ASCE 7 indicate that such contact could result in damage to the piping.

Spreaders shall be designed such that they occur at same interval as sway braces and at an equal distance between the sway braces.

If rack type hangers are used where the pipes are restrained from contact by mounting to the rack, spreaders are not required for pipes mounted in the rack.
****

A. Provide spreaders between adjacent piping runs as shown.

B. Spreaders shall be applied to surface of bare pipe, and over insulation on insulated pipes, utilizing high-density inserts and pipe protection shields in accordance with the requirements of Section 22 0713, Plumbing and HVAC Insulation.

3.8 SWAY BRACES FOR PIPING

****

Sway braces are required to prevent movement of the pipes under seismic loading.

Design of sway braces for a piping run shall be such that attachment to two dissimilar structural elements of a building that may respond differentially during an earthquake does not result, unless a flexible joint is part of the design. Reference paragraph SEISMIC RELATIVE DISPLACEMENTS.

Braces are required in both the longitudinal and transverse directions, relative to the axis of the pipe.

The bracing shall not interfere with thermal expansion requirements for the pipes as described in other sections of these specifications.

****

A. Transverse Sway Bracing for Piping

****

NOTE: Piping can be either rigid or flexible. Rigid piping has a period of vibration of 0.06 seconds or less. Piping systems with spacing between braces that exceeds allowable spacing for rigid piping will be deemed flexible and will be designed accordingly.

The bracing requirements stipulated below are based on flexible piping. Supports for flexible piping must consider an additional amplification if the piping is in resonance with the building.

All runs (length of pipe between end joints) shall have a minimum of two transverse braces.

The author should provide requirements for bracing PVC pipes.

****

1. Transverse sway bracing for steel and copper pipe shall be provided and installed as shown.

2. Transverse sway bracing for pipes of materials other than steel and copper shall be provided at intervals not to exceed the hanger spacing as specified in Section 22 0529, Hangers and Supports for Piping and Tubing.

B. Longitudinal Sway Bracing for Piping

****

NOTE: Design longitudinal sway braces for piping to meet the force and displacement provisions of ASCE 7. In addition, the design should take into account thermal expansion such that the sway braces do not interfere with expansion requirements.

All runs (length of pipe between end joints) shall have one longitudinal brace minimum.

Branch lines, walls, or floors shall not be used as sway braces.

****

1. Longitudinal sway bracing shall be provided and installed as shown.

C. Vertical Runs

****
NOTE: Design sway braces for vertical runs of piping to meet the force and displacement provisions of ASCE 7, such that bracing occurs above the center of gravity of the segment being braced.

All runs (length of pipe between end joints) shall have one longitudinal brace minimum.

Branch lines, walls, or floors shall not be used as sway braces.

****

1. Run is defined as length of pipe between end joints.

2. Sway bracing for vertical runs of piping shall be provided and installed as shown.

D. Anchor Rods, Angles and Bars

1. Anchor rods, angles, and bars shall be bolted to either pipe clamps or pipe flanges at one end and to cast-in-place concrete or masonry insert, or clip angles bolted to the steel structure, on the other end.

2. Provide bolts for attachment of anchors to pipe and structure shall be as shown.

3. Rods shall be solid metal or pipe.

E. Clamps and Hangars

1. Clamps or hangers on uninsulated pipes shall be applied directly to pipe.

2. Clamps or hangers on insulated pipes shall be applied over insulation vapor barrier with high-density inserts and metal protection shields under each clamp/hangar.

F. Shell Type Anchors Post-installed in Reinforced Concrete

1. The use of lead-cinch drop in anchors is not allowed.

3.9 SWAY BRACES FOR DUCTS

****
NOTE: Bracing details and spacing for rectangular and round ducts shall be in accordance with SMACNA Seismic Restraint Manual, including Appendix E. However, the design seismic loadings and displacements for these items shall not be less than loadings obtained using the procedures in ASCE 7.

Walls which ducts penetrate may be considered transverse braces.

Branch lines, walls, or floors shall not be used as sway braces.
****

A. Braced Ducts

1. Transverse Sway Bracing

a. Provide transverse sway bracing at intervals not to exceed those shown.

2. Longitudinal Sway Bracing

a. Provide longitudinal sway bracing at intervals not to exceed those shown.

B. Unbraced Ducts

1. Hangers for unbraced ducts shall be attached to the duct within 2 inches of the top of the duct [with a minimum of two #10 sheet metal screws] [ ].

2. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

C. Angles and Bars

1. Provide bracing angles and bars for ducts as shown.

3.10 CONCRETE BASES

****
Edit the following article to match project conditions; delete if concrete bases are not required.
****

A. Install a reinforced concrete base, not less than 4 inches high, for each piece of floor- mounted mechanical equipment.

****
Edit the following article to match project conditions; delete if not required. Use concrete bases with a permanent steel perimeter for heavy equipment.
****

B. Support each [ ] on a concrete equipment base with a permanent steel perimeter frame.

1. Form base using ASTM A-36 steel channels.

2. Construct concrete base not less than 4 inches larger in both directions than supported equipment. Miter and weld corners and provide cross bracing. Anchor or key to floor slab.

3. Install reinforcing bars tied to frame, and place anchor bolts, floor sills and sleeves using manufacturer's installation template. Refer to Section 03 3001, Reinforced Concrete.

4. Place concrete and provide a steel trowel finish on top. Refer to Section 03 3001 , Reinforced Concrete.

5. Clean exposed steel frames and apply 2 coats of rust-preventative metal primer and 2 coats of exterior, gloss, alkyd enamel in color selected by the Architect.

****
Edit the following article to match project conditions; delete if not required. Use concrete bases without a permanent steel perimeter for relatively light floor–mounted equipment.
****

C. Support each [ ] on a formed concrete equipment base.

1. Form concrete equipment bases using framing lumber with form release compounds. Refer to Section 03 3001, Reinforced Concrete.

2. Construct concrete base not less than 4 inches larger in both directions than supported unit.

3. Install reinforcing bars, and place anchor bolts, floor sills and sleeves using manufacturer's installation template. Refer to Section 03 3001, Reinforced Concrete.

4. Place concrete and provide a steel trowel finish on top; chamfer top edges and corners. Refer to Section 03 3001, Reinforced Concrete.

D. Cure concrete not less than seven days before installing equipment.

3.11 ANCHOR BOLTS

A. Refer to Section 03 15 05, Concrete Anchors.

3.12 FASTENING

A. Refer to Section 13 4800, Sound, Vibration and Seismic Control.

3.13 SPECIAL INSPECTION AND TESTING FOR SEISMIC-RESISTING SYSTEMS

A. Refer to Section13 4800, Sound, Vibration and Seismic Control.

END OF SECTION

****
Do not delete the following reference information.
****

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 22 0548 Rev. 0, January 6, 2006.